Glossary

Best Management Practice (BMP): A method that has been determined to be the most effective, practical means of preventing or reducing pollution from non-point sources.

Designated Uses: Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act. Uses can include cold water fisheries, public water supply, irrigation, and others.

Discharge Monitoring Report (DMR): The EPA uniform national form, including any subsequent additions, revisions, or modifications for the reporting of self-monitoring results by permitees. DMRs must be used by approved stated as well as by EPA.

Discharge: Flow of surface water in a stream or canal or the outflow of groundwater from a flowing artesian well, ditch, or spring. Can also apply to discharge of liquid from a facility or to chemical emissions into the air through designated venting mechanisms.

Downstream Trade: A water quality trade in which one source compensates another source downstream of its position within the watershed for producing an environmentally equivalent pollutant reduction impact at all pertinent compliance points within the watershed.

Effluent: Wastewater, treated or untreated, that flows out of a treatment plant, sewer, or industrial outfall.

Incremental cost: The average cost of control for the increment of reduction required for an individual source to meet compliance. For example, if a discharger needs a 5 lbs./day reduction to comply with requirements but that drives a $10 million technology investment that actually reduces 20 lbs./day, then the incremental cost associated with the 5 lbs./day is substantial relative to the average cost of reductions. Traditional average cost would divide costs by 20 lbs./day; incremental analysis divides the costs by 5 lbs./day and would be four times higher than average cost.

Indirect Discharge: A non-domestic discharge introducing pollutants to a publicly owned treatment works.

Load Allocation: The portion of a receiving water's loading capability that is attributed to either one of its existing or future non-point sources of pollution or to natural background sources. Load allocations are best estimates of the loading which can range from reasonable accurate to gross allotments, depending on the availability of data and appropriate techniques for predicting loading.

National Pollutant Discharge Elimination System (NPDES): The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits and imposing and enforcing pretreatment requirements under Sections 307, 402, 318, and 405 of the Clean Water Act.

Non-point source: Diffuse pollution sources (i.e., without a single point of origin or not introduced into a receiving stream from a specific outlet). The pollutants are generally carried off the land by stormwater. Common nonpoint sources are agriculture, forestry, urban mining, construction, dams, channels, land disposal, saltwater intrusion, and city streets.

Overcontrol: Taking steps to reduce pollutant discharge below the waste load allocation for individual point sources or the load allocation for nonpoint sources.

Point source: Any discernible confined and discrete conveyance, including, but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel, or other floating craft from which pollutants are or may be discharged.

Total Maximum Daily Load (TMDL): The sum of the individual waste load allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and natural background. TMDLs can be expressed in terms of mass per time, toxicity, or other appropriate measure that relates to a state's water quality standard.

Upstream Trade: A water quality trade in which one source compensates another source upstream of its position within the watershed for producing an environmentally equivalent pollutant reduction impact at all pertinent compliance points within the watershed.

Appendix A

Water Quality Trading Suitability Profile for *Phosphorus*

TRADING SUITABILITY OVERVIEW

The EPA Water Quality Trading Policy supports nutrient (e.g., total phosphorus and total nitrogen) trading. Sources of phosphorus include background sources such as natural springs, point sources such as municipal sewage treatment plants and food processors, and non-point sources such as irrigated agriculture. Water quality trading pilot projects across the country have demonstrated that phosphorus from these and other sources can be successfully traded. These projects have found that phosphorus discharges and in-stream concentrations can be readily measured at key points within a watershed, and that the pollutant is relatively stable as it travels through river systems. As a result, phosphorus dischargers will have a reasonable ability to establish environmental equivalence relationships between themselves or between a discharger and a compliance point.

TMDLs address phosphorus and nitrogen to control a number of water quality problems including aquatic plant growth, low dissolved oxygen, and high pH. To establish equivalence appropriately, trading parties will need to understand how their load connects to the specific problem. Phosphorus and nitrogen are nutrients which are often associated with eutrophication in fresh waters. Excessive phosphorus contributes to exceeding the narrative water quality criteria established by many states relating to nuisance aquatic plant growth, deleterious materials, floating, suspended, or submerged matter, oxygen-demanding materials, or other similar standards. Excessive phosphorus concentrations have both direct and indirect effects on water quality. Direct effects include nuisance algae and periphyton growth. Indirect effects include low dissolved oxygen, increased methylmercury production, elevated pH, cyanotoxins from blue-green algae production, trihalomethane production in drinking water systems, and maintenance issues associated with domestic water supplies.

Most TMDLs recognize the correlation between phosphorus concentrations and these water quality concerns. Excess nutrient loading causes excess algal growth within the water column, which in turn affects levels of dissolved oxygen and pH in aquatic systems. This correlation between phosphorus concentrations and other water quality concerns can be seen in the Draft Snake River- Hell's Canyon TMDL recently developed by the states of Idaho and Oregon. In this TMDL, concentration levels are established for both Chlorophyll a and Total Phosphorus to ensure that nutrient concentrations do not result in excessive algae or other aquatic growth, which may impede the attainment of water quality standards for dissolved oxygen and pH.

KEY TRADING POINTS

A. Phosphorus Pollutant Form(s)

Total Phosphorus TMDLs —Most TMDLs establish load allocations for Total Phosphorus, although levels of both Total Phosphorus and Ortho-phosphorus are often monitored. Total Phosphorus is, however, comprised of two forms:

- Soluble—also known as Dissolved Ortho-phosphate or Ortho-phosphorus—includes highly soluble, oxidized phosphorus. Because of its solubility, ortho-phosphorus is commonly more available for biological uptake and leads more rapidly to algal growth than non-soluble phosphorus.
- Non-Soluble—also known as Sediment-Bound or Particulate-Bound phosphorus—is mineral phosphorus incorporated in sediment and is not as likely to promote rapid algal growth, but has the potential to become available to plants over time.

The concentration of total phosphorus is calculated based on the sum of the soluble and non-soluble phosphorus. Due to phosphorus cycling in a waterbody (conversion between forms) TMDLs usually consider Total Phosphorus concentrations. Total Phosphorus then represents the phosphorus that is currently available for growth as well as that which has the potential to become available over time.

Sources covered by a Total Phosphorus TMDL will be measuring discharges and reductions using a common metric. Use of this common metric for measuring phosphorus reductions in a TMDL should provide a high potential for matching phosphorus discharges from various sources in the watershed. It will be important, however, to understand the actual forms of phosphorus being discharged because some trades may not represent an equivalent impact on water quality. For example, if individual dischargers have substantially divergent load characteristics (e.g., one primarily discharges soluble phosphorus while another primarily discharges non-soluble phosphorus) then a trade between the two may not be environmentally equivalent. If a high percentage of the total phosphorus is present as soluble ortho-phosphate, it is more likely that rapid algal growth will occur than if the majority of the total phosphorus is mineral phosphorus incorporated in sediment. Adjustments, using a trade ratio or other means of establishing and equivalence relationship, may be needed to account for such differences.

Other Phosphorus-Related TMDLs—To the extent that a TMDL establishes load allocations in terms of individual phosphorus forms, challenges to trading may exist. If a TMDL provides load allocations for different forms, participants in the watershed will be limited to trading within two, smaller, more constrained markets for each form. Alternatively, a reliable translation ratio may be generated to create broader trading opportunities.

There may be circumstances where some dischargers receive phosphorus allocations while others receive dissolved oxygen allocations. There is a known and well-characterized link between phosphorus concentrations and dissolved oxygen problems. This relationship provides an opportunity to establish a specific translation ratio between Total Phosphorus and Dissolved Oxygen, potentially enabling additional trading opportunities. For example, under the Draft Snake River-Hells Canyon TMDL, Idaho Power Company was given a load allocation for DO, while municipal, industrial, and agricultural sources have received Total Phosphorus allocations. Idaho DEQ is exploring the development of a total phosphorus/dissolved oxygen (TP/DO) translation ratio, which would enable Idaho Power to become a potential purchaser of TP surplus reductions from other sources.

B. Impact

Adjusting for Fate, Transport, and Watershed Considerations—In general, phosphorus fate and transport are sufficiently well understood, and the models used to develop phosphorus TMDLs are reasonably well suited, to support the development of environmental equivalence relationships among potential phosphorus trading parties. The phosphorus "retentiveness" of a water body describes the rates that nutrients are used relative to their rate of downstream transport. As ratios are set for trading opportunities, the factors that contribute to retentiveness should be considered. Areas of high retentiveness are usually associated with low flows, impoundments, dense aquatic plant beds, and heavy sedimentation. Trades that involve phosphorus loading through these areas will likely require high ratios (e.g., 3:1) to achieve environmental equivalence between dischargers. In areas with swift flowing water and low biological activity, phosphorus is transported downstream faster than it is used by the biota, resulting in low levels of retentiveness and minimal aquatic growth. In areas of low retentiveness, where phosphorus is transported rapidly through the system, low ratios (e.g., 1.1/1) will likely emerge.

Other factors, including substrate stability and light contribute to plant growth and factor into a segment's "retentiveness." Sedimentation is another condition that can affect how phosphorus will move through and be utilized in a system. Phosphorus is often found in sediments and will persist longer in them. As a result, the presence of these factors should be an explicit consideration in setting environmental equivalence ratios.

<u>Examining Local Considerations</u>—In a downstream trade, the upstream source will not meet its allocation under the TMDL because it is purchasing reductions from another source downstream. Discharges from the upstream source will not be reduced, and water quality will not be improved in the segment between the two sources. Overcontrol by the downstream source will result in improved water quality further downstream. These types of trades will only avoid unacceptable localized impacts if the segment between the two sources has not reached its assimilative capacity.

Additionally, a trade, irrespective of its direction (up or downstream), involving sources discharging substantially different phosphorus forms may be vulnerable to creating localized impacts. In particular, a trade that involves offsetting a primarily soluble phosphorus discharge with a sediment-attached discharge will leave a greater quantity of readily available phosphorus in the water body than otherwise would have been the case. This readily available phosphorus has the potential, as discussed earlier, to contribute to short-term, local nuisance aquatic growth problems.

C. Timing

The key time element to consider when examining phosphorus trading is the seasonal load variability among dischargers. Agricultural non-point sources usually discharge during the growing season only, i.e., between April and October. Point sources generally discharge all year round. The relative importance of this difference plays out in the context of how TMDL phosphorus allocations are set. Many TMDLs provide seasonal phosphorus load allocations that apply only during those months of the growing season. The potential for excessive algal growth occurs predominately in the summer when sufficient light and temperature conditions support plant growth. Under these circumstances, both point and non-point sources will likely receive a seasonal allocation, and their ability to match reduction needs with the timing of phosphorus reduction credits will overlap and readily support trading. However, allocations to lakes or other large water bodies may be annual because of the relationship in these water bodies between annual phosphorus loadings and eutrophication. In such cases, sources receiving year-round allocations may be restricted from trading with sources that produce seasonal loads.

D. Quantity

Typically, phosphorus TMDLs establish WLAs and LAs in terms of concentration or mass based reductions. For the most part, these allocations provide a straight forward means to establish over control for purposes of identifying marketable reductions. For example, a POTW with a permit limit established at 700 lbs./day that currently discharges 600 lbs./day, will have 100 lbs./day of marketable reductions. However, for some non-point sources, estimates may need to be utilized to establish the level of phosphorus reductions. This will likely be needed when sampling a discharge is complex, infeasible, and/or not cost effective. Pilot projects have used estimation methods based on the type and degree of BMP implementation to establish phosphorus reductions. Such estimates should be based on the type and extent of BMP implementation and local conditions. While less precise, if conservative assumptions are utilized, the degree of control which can be achieved with various BMPs can be estimated and utilized for trading purposes. Thus, in either case, reasonably well established methods exist for understanding the degree of over control achieved by phosphorus sources and enabling trading parties to clearly verify the existence of marketable reductions.

Appendix B

Water Quality Trading Suitability Profile for *Temperature*

TRADING SUITABILITY OVERVIEW

Unlike nutrient trading, which has been piloted in a number of areas around the country, there is very little experience trading water temperature. The EPA Water Quality Trading Policy does recognize that trading of pollutants other than nutrients and sediments has the potential to improve water quality and achieve ancillary environmental benefits if trades and trading programs are properly designed. Issues related to determining the tradable commodity and establishing environmental equivalence are currently being considered in a few watersheds in EPA Region 10. These efforts, as well as discussions within Region 10, indicate that temperature impacts, fate, and transport are sufficiently well understood to support at least some level of trading among sources of elevated temperature sources. The current expectation is that environmental equivalence can be established through direct sampling and through the models used in TMDL development.

Temperature standards have been established to protect beneficial uses such as cold water biota, salmonid spawning and rearing, and anadromous fish passage. TMDLs in Region 10 address water temperature primarily to protect cold water fish (salmonids) as the most sensitive beneficial uses. As of 1996, water temperature was addressed in 240 TMDLs in Region 10 (38 by Idaho, 141 by Oregon, and 61 by Washington). Water temperature is also an important consideration in Region 10 because a number of salmonid species listed as threatened or endangered under the Endangered Species Act (ESA) inhabit these waters and require improved water quality to support survival and recovery.

In Region 10, water temperature has direct and indirect impacts on native salmonids, bull trout, and other species listed under the ESA. Water temperature affects all life stages of these fish. It directly affects spawning, rearing, feeding, growth, and overall survivability. The incidence and intensity of some diseases are directly related to increased water temperatures. Indirect effects include changing food availability, increasing competition for feeding and rearing habitat, and enhancing the habitat for predatory fishes. Increased water temperature also indirectly affects water quality by increasing the toxicity of many chemicals, such as un-ionized ammonia. High water temperatures reduce DO concentrations by increasing plant respiration rates and decreasing the solubility of oxygen in water.

Sources of elevated temperature increases usually include both natural loading (from high air temperatures and solar radiation) and anthropogenic loading (from point source discharges and nonpoint sources such as devegetation of riparian areas, agricultural and stormwater drains, and tributary inflows). Non-point sources contribute to solar radiation heat loading by removing near stream vegetation and decreasing stream surface shade. In urban areas, impervious surfaces reduce the cooling effect of natural infiltration of surface runoff and increase the temperature of stormwater inflows. The Pacific Northwest State and Tribal Water Quality Temperature Standards[11] identified the four largest sources of increased temperature in the Pacific Northwest to be 1) removal of

[11] *Pacific Northwest State and Tribal Water Quality Temperature Standards* (US EPA, April 2003, 901-B-03-002)

streamside vegetation, 2) channel straightening or diking, 3) water withdrawals, and 4) dams and impoundments.

KEY TRADING POINTS

A. Temperature Pollutant Form(s)

Temperature TMDL allocations are designed to limit human-caused water temperature increases and to meet the applicable water quality standards. The standards are usually expressed as specific limitations on surface water temperatures, as expressed in degrees. For example, temperature load capacity in the Snake River-Hell's Canyon TMDL is defined (through Oregon state standards) as no measurable increase over natural background levels. The quantitative value used by Oregon Department of Environmental Quality as "no measurable increase" is 0.25°F (0.14° C).

Most TMDLs provide temperature waste load allocations to point sources in degrees Centigrade, (°C), degrees Fahrenheit (°F), or as heat per unit time, such as BTU's or Kilocalories per day. In effect, allocations establish what volume of discharge at a given temperature may enter a water body over a given period of time.

For non-point sources, temperature load allocations are often expressed as "no anthropogenic increase" or no loading by human sources. For ease of implementation these are also expressed in terms of percent of stream area shade required, providing site-specific targets for land managers. In temperature impaired reaches, non-point sources often meet this target by allowing stream banks to revegetate naturally until it attains "system potential," or the near stream vegetation condition that would naturally grow and reproduce on a site, given elevation, soil properties, plant biology, and hydrologic processes.

Although point and non-point sources tend to receive different forms of temperature allocations, models have been developed to convert the effect of increased stream shade into degrees cooling. Oregon DEQ uses several different models during TMDL development. The "Heat Source" model uses multiple data sources related to temperature, vegetation, and hydrology to accurately predict stream temperature at 100-foot distances. Other models are used to simulate stream temperatures for various hypothetical riparian restoration strategies. These models provide a basis for converting between point and non-point source temperature reductions for purposes of trading allocations.

B. Impact

<u>Adjusting for Fate, Transport, and Watershed Conditions</u>—In general, temperature fate and transport are sufficiently well understood, and the models to develop temperature TMDLs are reasonably well suited, to support the development of environmental equivalence relationships among potential temperature trading parties. Moreover, EPA Region 10 temperature guidance currently supports the establishment of a mixing zone for temperature discharges. If a similar provision is included in the state's water quality standards and utilized in the development of the WLAs in the TMDL, this provides for some mixing between the discharge water and receiving stream. If the receiving water is sufficiently cool as a result of upstream overcontrol, additional mixing may be allowed provided that the temperature standard is met at the edge of the mixing zone.

However, water temperature fluctuates in response to natural conditions, such as ambient air temperature, solar heating, and flows. Thus, the temperature effects of control options can dissipate quickly as water bodies rapidly reach a new water temperature equilibrium with the atmospheric and hydrologic conditions. As a result, although models and sampling can be used to predict and track the impacts of water temperature reductions at locations in a watershed, major water temperature effects are not likely to be seen at distant locations. For trading purposes, this suggests that potential trading parties will likely need to reside in relatively close proximity to each other for an environmentally equivalent trade to emerge.

A second aspect of assessing the environmental equivalence of temperature reductions relates to the potential importance of cold water refugia in streams which provide salmonid habitat. Although temperature load allocations are designed to meet the numeric criteria of applicable water quality standards, narrative standards also often address the need to protect ecologically sensitive cold-water refugia. Thus, it will be important to identify how sources of temperature impacts are connected to these refugia. If these connections can be modeled to determine how overcontrol options can benefit refugia, then trading opportunities that provide targeted temperature improvements to refugia can be explored. In this context, and as discussed under the Quantity section below, certain locations of temperature reductions will be of higher quality (more valuable to protection of the desired beneficial use) and therefore more desirable. To the extent a trading system can recognize this value and help to steer reductions to these areas it can substantially support the TMDL goals.

<u>Examining Local Considerations</u>—Certain forms of temperature trades hold the potential to create localized impacts. In some areas, high water temperatures can have harmful or even lethal impacts on fish populations. In other areas, fish may be able to avoid the hotspots with little effect on the species. The creation of a mixing zone under NPDES permits will provide some flexibility in this context, although the expectation is that even if standards are met at the zone's edge, there will be elevated temperature impacts at and in close proximity to the discharge point. Any established threshold temperature level will be site and conditions specific, and watershed participants should expect that the presence of cold water refugia will almost certainly require limitations on the degree to which a source could exceed their temperature allocation and mitigate through trading. In general, caps on purchasing activity placed in NPDES permits will be a primary means to control for local temperature impacts.

C. Timing

Exceedances of temperature-related water quality standards are more likely to occur in the summer months. As a result, temperature TMDLs have focused allocations seasonally, with required temperature reductions applying at the typically hottest times of the year. In response, many waste load allocations provide (or are expected to provide) different allocations for various times of the year, with more stringent limits during summer months and salmonid spawning or other life cycle periods that are critical to fish survival. In general, this seasonal approach supports opportunities for point sources and non-point sources to consider temperature trading options. Irrespective of the temperature allocation cycle, non-point source temperature reduction efforts in the form of shade are seasonally dependent, as greater cooling effects are provided from the shade during this period. Most nonpoint source temperature allocations are not seasonal—thus encouraging the vegetation to be in place year-round and indirectly support channel stability and other key channel characteristics. Under a seasonal temperature TMDL, point sources' need for reductions or willingness to overcontrol will coincide with the non-point sources ability to influence stream temperature, thus establishing a strong match for trading from a timing standpoint.

D. Quantity

Based on the nature of temperature allocations and related control options, both point and non-point sources of temperature impacts have the ability to over control their “discharge” and create temperature credits. For point sources, overcontrol would take the form of lowering discharge temperature below that required in a TMDL. In instances where the point source is a significant contributor to elevated in-stream temperatures (e.g., the discharger’s flow is greater than the in-stream flow with a temperature 50 percent higher), the impact of over control will likely be discernable for some distance. This situation would readily support upstream trading with other point or non-point sources. In EPA Region 10, however, most point sources of heat are relatively small and have limited thermal loads. As a result, it is anticipated that their over control would quickly be offset by more dominant in-stream and riparian conditions. Trading opportunities, as a consequence, would be constrained to other sources in very close proximity to the source of over control.

In order to attain most non-point source allocations in temperature TMDLs, land along streams would need to achieve site potential shade. Natural re-vegetation varies with species, climate, and local conditions, requiring between 20 and 80 years to achieve site potential shade. If there are no state or local measures in place requiring landowners to actively plant and restore riparian areas, non-point sources can over control by influencing stream area shade in three ways: 1) earlier shade creation through tree planting; 2) more effective shade creation through selection of planted vegetation with a denser canopy; and 3) increasing the total shaded area of the stream.

In Region 10, tree planting programs that substantially advance the creation of shade as compared to natural re-vegetation have emerged as strong candidates for creating over control. Current thinking indicates that generating temperature benefits sooner than would be present under either natural or required stream bank re-vegetation can be used, at least temporarily, as reduction credits available for trading. The value of these credits may be quite high, as they are potentially available for at least five and possibly up to fifteen years, allowing other sources to delay what might otherwise be very substantial capital expenditures to reduce discharge temperatures.

Other means of non-point source over control are more theoretical at this time. Although it remains an untested concept, certain trees that create a denser and/or higher canopy than natural vegetation may produce greater shading and thus reduce the warming effects of sun light. Under such an approach, tree planting would not only produce temperature benefits earlier than natural re-vegetation, it would create a more consistent and/or greater area of shade than described in the TMDL. If utilized, tree selection should take into consideration a diversity of species and the ability of the re-vegetated community to sustain other functions of the riparian area.

Additionally, in instances where TMDLs do not require site potential shade throughout a watershed, expanding the area of stream bank vegetation beyond TMDL allocations could represent over control. However, Region 10 temperature TMDL experience to date indicates that a typical TMDL approach will be to require natural re-vegetation throughout the TMDL area, substantially reducing the opportunity for this option.

Both point and non-point sources may have two additional options for creating temperature reduction credits for either their own use or for sale to others. First, modifications to channel complexity that return streams to more natural width-to-depth ratios may result in temperature reductions. Moreover, reestablishing tree-covered islands in mid stream is another channel modification that can create additional shading effects to reduce water temperature.

Second, water volume and flow are critical factors affecting water temperature. Creative solutions to water temperature problems often involve changes in flow regimes. Water temperature improvement measures relating to flow include changes in location of discharges, increases in irrigation efficiencies, and water right purchases or leases. It is likely that any such changes in flow regimes that result in improved temperature conditions can be easily accounted for with models used in the development of the TMDL.

Irrespective of the means by which non-point sources achieve over control, these actions hold the potential to be more attractive than point source temperature reductions from an overall watershed health standpoint. Non-point source over control options that accelerate the return of vegetation in riparian areas provides important benefits to water quality and fish and wildlife habitat. Increased vegetation along stream banks helps to maintain temperature improvements from other sources. Increased vegetation in riparian areas support other water quality objectives by reducing erosion, sediments, and providing natural filtration of water entering the stream. Vegetated stream banks improve the health of riparian areas, which provide important habitat for many types of wildlife and aquatic species. As a result, a trade in which a point source opts to pay for non-point source over control may prove highly desirable from an overall watershed health perspective.

Appendix C

Water Quality Trading Suitability Profile for *Sediments*

TRADING SUITABILITY OVERVIEW

The EPA Water Quality Trading Policy specifically supports sediment trading. Sources of sediments include both natural and anthropogenic sources. Soil erosion from surface water flow is the largest natural source of sediments. Erosion from high flow events, such as flash floods or snow melt can result in greater sediment deposition in a single large event than occurs all year from average flows. Nonpoint sources of sediment include agricultural sources such as plowing and flood and furrow irrigation, forestry sources, such as logging and stream bank disturbance, and urban/suburban sources including construction, stormwater runoff, and irrigation. Point sources generally contain sediment discharge limits in their NPDES permits but are usually not major contributors to sediment concentrations.

Region 10 has had limited experience considering sediment trading opportunities. However, other areas of the country have had more experience with sediment trading, with pilot projects involving sediments conducted in the Delaware River, PA, the Truckee River, NV, and the Lower Smith River, VA.

Water quality standards are developed to protect the most sensitive beneficial use and have generally been established for sediments to protect designated uses associated with aquatic life. They are often based on both a numeric standard related to turbidity (e.g., 50 NTU's above background), and a narrative standard that protects beneficial uses. Narrative standards are translated into a wide range of numeric criteria depending on the conditions in the watershed, the fish species present, and the interpretation of the agencies and stakeholders in the area.

TMDLs address sediments to meet water quality standards and control a number of water quality problems. To establish appropriate environmental equivalence, trading parties will need to understand how their sediment loads connect to the specific problem. High concentrations of sediment can have both direct and indirect effects on water quality. Excessive amounts of sediment can directly impact aquatic life and fisheries. Excessive sediment deposition can choke spawning gravels, impair fish food sources, and reduce habitat complexity in stream channels. Excessive suspended sediments can make it more difficult for fish to find prey and at high levels can cause direct physical harm, such as scale erosion, sight impairment, and gill clogging. Stream scour can lead to destruction of habitat structure. Sediments can cause taste and odor problems for drinking water, block water supply intakes, foul treatment systems, and fill reservoirs. High levels of sediment can impair swimming and boating by altering channel form, creating hazards due to reductions in water clarity, and adversely affecting aesthetics.

Indirect effects associated with sediment include low dissolved oxygen levels due to the decomposition of organic sediment materials, and water column enrichment by attached pollutant loads, such as nutrients, or legacy application of DDT or mercury-based seed treatments. Elevated stream bank erosion rates also lead to wider channels which can contribute to increased temperatures. Sediment targets and monitored trends often function as indicators of reductions in transport and delivery of these attached pollutants.

Sedimentation is also an important consideration in Region 10 because a number of species listed as threatened or endangered under the Endangered Species Act (ESA) inhabit impaired waters in the region and require cold, clear, well oxygenated water to support spawning, survival, and recovery.

KEY TRADING POINTS

A. Sediment Pollutant Form(s)

Sediment TMDLs—Sediment is discharged by sources in a wide range of particle sizes and weights. TMDLs generally provide separate load allocations for sediments based on two different particles sizes.

- Suspended or "water column" sediments are particles that are small and light enough to remain suspended in the water column, generally less than 1 mm. Sources also discharge two different types of these suspended sediments. Nonpoint sources discharge geological particles, which are derived from rock and soil. Point sources, such as wastewater treatment plants, usually discharge biological particles as part of the treated wastewater. These different forms of suspended sediments may have different impacts on water quality. As discussed below, TMDLs often establish different load allocation forms for point and nonpoint sources to control water column sediments.
- Bedload sediments are larger particles that are too heavy to be suspended in the water column. They are generally discharged by nonpoint sources and are transported by sliding, rolling, or bouncing along the bed of the stream. Bedload sediments consist of particles greater than 1 mm in diameter and can range in size from sand and gravel to small pebbles or large boulders. TMDLs often establish mass-based load allocations for bedload sediments such as pounds per day or tons/square mile/year of sediment loading, or use a percentage of fines deposited in stream bottoms.

TMDLs often establish different load allocation forms for point and nonpoint sources. Waste load allocations for point sources often use concentration-based limits, such as an average weekly limit of 45 mg/L of Total Suspended Solids (TSS). Load allocations for nonpoint sources are often expressed in mass-based allocations, such as tons/square miles/year of sediment loading. Point source dischargers with similar sediment discharge forms and waste load allocation metrics may have trading opportunities. For example, two POTWs from neighboring jurisdictions in Virginia have entered into a cooperative agreement whereby one POTW has agreed to a reduction in its permit limit for discharging total dissolved solids so the other can have an increased limit. The allocations are both expressed in terms of kg/day of total dissolved solids. The two plants discharge into the same stream segment and the Virginia DEQ has determined that the agreement would not result in a decrease in water quality. However, point sources will also need to be aware of the form of sediment being discharged. A point source discharging a biological form of sediment can have different water quality impacts than a source discharging a geological form.

B. Impact

Adjusting for Fate and Transport Characteristics and Watershed Considerations—As dischargers consider trading opportunities, it will be important to understand the specific water quality impacts of each potential trading partner. Sediment load reductions by sources may be measured directly by sampling, with the models used to develop sediment TMDLs, or using surrogate measures, such as percentage of fines in stream bottoms. Other site specific watershed conditions, such as velocity, slope, channel conditions, and type of sediment, are important considerations for understanding water quality impacts and matching potential trading partners.

For suspended sediments, models are available to determine the impacts of reductions. However, depending on the watershed conditions, and the water quality problem that is being addressed, geological and biological forms of suspended sediments may have different impacts. It is likely that trading between similar forms (e.g., geological to geological, and biological to biological) will support water quality improvements. But trading between different forms of suspended sediments will be dependent on the water quality impacts that each reduction is intended to address. For example, if a source's reduction in geological suspended sediments is intended primarily to reduce levels of attached phosphorus, then a trade with a source discharging a biological form of suspended sediments will not meet the water quality improvement needs of the watershed. However, if suspended sediment reductions are intended primarily to reduce turbidity, then a trade between two different forms may be supported.

While bedload sediment reductions may also be easily modeled, the impacts of bedload sediments are generally experienced relatively close to the source of discharge as the heavier particles are transported very slowly along the river bottom. Thus, opportunities for trading bedload are likely to be limited to geographically smaller market areas. Because suspended sediments and bedload sediments will have different impacts on water quality, it is unlikely that there will be direct opportunities for trading between these two different forms of sediment.

Watershed flow patterns are also likely to define market areas for trading. Sediment movement in a stream varies as a function of flow. Suspended sediments discharged into high flow areas will travel longer distances and may define a large market area. The boundaries of markets may be defined by lower flows areas. The areas usually occur in the lower sections of watersheds where flows decrease and the lighter, smaller suspended sediments fall out. Upper sections of watersheds with higher flows often transport more bedload sediment. Impoundments create significant barriers that restrict sediment transport and create areas of sediment deposition. These distinct areas, based on flow patterns, are likely to delineate defined trading market areas, with trading limited to within each defined area.

<u>Examining Local Considerations</u>—Because watershed conditions relating to velocity, slope, and channel conditions will directly affect the impact of sediment reductions, each trade will have to be assessed to determine the potential for localized impacts. As with other pollutants, downstream trades will only avoid unacceptable localized impacts if the segment between the two sources has not reached its assimilative capacity. Additionally, a trade, irrespective of its direction (up or downstream), involving sources discharging substantially different sediment forms may be vulnerable to creating localized impacts. For example, a trade that involves offsetting a biological form of suspended sediment discharge with a geological form of suspended sediment discharge will leave a greater quantity of biological sediments in the water column. This form of sediment may have a greater impact on dissolved oxygen levels and may lead to unacceptable dissolved oxygen-related water quality problems.

C. Timing

Although sediment delivery to streams from nonpoint sources is an inherently seasonal phenomenon, sediment allocations are generally applied year round. Allocations are expressed as an average amount of sediment per year. To account for variability between years (i.e., years with high snow melt or other extreme weather events will have higher sediment delivery) some TMDL load allocations are expressed as ten year rolling averages. Because sediment load allocations are generally applied on an average basis year round, participants will be likely to align reductions between potential buyers and sellers.

D. Quantity

There are a number of ways that sources can apply control options to reduce sediment loads. These controls can be sampled and/or modeled to determine the amount of sediment reduction beyond TMDL allocations.

Point sources can apply technological control options that result in a measurable change in sediment concentration and associated loads. Permit limits for point sources are usually based on a technology-based limit which may be lower than required to meet the TMDL target. Under the Clean Water Act, point sources are required to comply with their technology-based limits, irrespective of watershed conditions or their opportunities to trade. Under such circumstances, there is no incentive for such sources to become purchasers of sediment reductions. However, in circumstances where the technology-based limit is higher than the water quality standards, incentives for trading may exist.

In many watersheds experiencing sediment related water quality problems, point sources are often only minor contributors to excessive sediment loads. Therefore, they may have a limited capacity to overcontrol in a meaningful way to improve water quality. As discussed above, point sources also discharge a different form of suspended sediment. Point sources may be limited to trading with other sources discharging similar forms. Nonpoint sources have the ability to overcontrol using more aggressive controls than required to meet load allocations, using controls that cover broader areas, or using controls that target more valuable areas for sediment reduction.

Nonpoint sources can overcontrol using Best Management Practices (BMPs). Aggressive BMPs, such as conversion to drip irrigation on agricultural lands have the ability to reduce sediment loads below TMDL allocations. BMPs can also be applied to cover broader areas than specified in a TMDL.

Another potential overcontrol option is for sources to select higher value areas to apply nonpoint BMPs, thus achieving higher reductions in the waterbody of concern. Marketable reductions may be generated by applying control options that focus on areas with highly erodible soils, or areas that have a direct impact on the beneficial use, such as salmonid spawning areas, and may create a greater improvement in water quality than specified under the TMDL allocation.

BMPs can be modeled to project the reduction in sediment loading. However, models used in TMDL development usually provide only very coarse estimates of sediment loading. Because of the limitations of models in projecting sediment reductions, TMDLs often use surrogate measures that provide a more direct connection to the beneficial use that is being protected. Measures such as the depth of sediment fines in riffle pools are used in addition to the numeric targets to assess sediment reductions. These methods should allow nonpoint sources to calculate the amount of reductions beyond TMDL load allocations.